DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 2/23/10 has been entered.

2. The amendment filed 2/23/10 has been entered. Claims 1-3, 5-9 and 11-16 are pending in the application. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim Rejections - 35 USC § 103

3. Claims 1-3, 5-9 and 11-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Summers et al for the reasons of record and restated below.

4. Summers et al teach a metal/polyimide laminate comprising a vapor deposited metal layer on one or both sides of a polyimide base film having a linear expansion coefficient matched to the metal and a modulus from 800-1200kpsi, wherein a thermoplastic polyimide adhesive layer may be incorporated between the metal layer and the polyimide base film by applying the adhesive to the polyimide base film and drying, thereby improving adhesion between the base film and the metal (Col. 6, line 53-Col. 7, line 20; Col. 12, line 55-Col. 14; Col. 15, line 8-26; Examples.) Summers et al also teach that a coupling agent can be used as a pretreatment of the polyimide film, wherein the coupling agent can be coated on the film surface as a solution and may include a silane-based, titanium-based, or aluminum-based coupling agent, to improve

adhesion between the base film and the metal (Col. 14, line 9-31.) Summers et al also teach that the adhesion between the polyimide film and the metal can be increased by subjecting the polyimide film to heat treatment step from 200°C to 600°C (Col. 13.) Summers et al teach that a circuit pattern can be formed on the metal/polyimide laminate broadly by application of a resist, photo-patterning and development of the resist, copper etching and removal of the resist as instantly claimed (Col. 12, lines 55-67.) Summers et al do not specifically teach that the laminate is produced by incorporating the thermoplastic layers, the coupling agents, and the heat treatment step, however, given that Summers et al teach that all three provide improved adhesion between the polyimide base and the deposited metal, one having ordinary skill in the art at the time of the invention would have been motivated to incorporate intermediate thermoplastic layers and subjecting the polyimide base with the thermoplastic polyimide layers to subsequent adhesion enhancement steps taught by Summers et al including applying the coupling agents to the thermoplastic layers and heat treating the resulting laminate prior to depositing the metal, given the reasonable expectation of success. With respect to Claim 2, though Summers et al do not specifically teach the Tg of the thermoplastic adhesive layer, it would have been obvious to one having ordinary skill in the art at the time of the invention to utilize a thermoplastic polyimide having a Tg equal to or lower than the Tg of the base film, specifically around 300°C.

5. Claims 1-3, 5, 7-9, and 11-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hara et al for the reasons of record and restated below.

6. Hara et al teach a laminate comprising thermoplastic polyimide layers applied to one or both sides of a non-thermoplastic polyimide base film and then dried, followed by sputtering a

conductor or copper layer on the thermoplastic surface layer(s) subjected to heat treatment step, followed by a wet plating method such as electroplating to obtain the desired conductor layer thickness (Entire document, Abstract; Paragraphs 0016-0030; 0041.) Hara et al teach that the heating temperature is preferably 30°C or higher than the glass transition temperature of the thermoplastic polyimide, wherein when a polyimide having a glass transition temperature of 150°C, for example is utilized, the heating temperature preferably ranges from 150° to 280°C (Paragraph 41-42.) Hara et al also teach that adhesion between the thermoplastic polyimide layer and the metal can be improved by various surface treatments including surface roughening treatment as well as introducing a functional group to further enhance the adhesion strength (Paragraph 044.) Hara et al further teach examples wherein a thermoplastic resin having a glass transition temperature of 190°C is utilized (Examples.) Hara et al do not specifically teach the linear expansion coefficient of the non-thermoplastic base film with respect to the conductor or copper layer, however, it is well established in the art that matching of the CLE or CTE of the polyimide base film to the copper or conductor layer provides improved mechanical properties in the art, including reduced curling, and hence one having ordinary skill in the art at the time of the invention would have been motivated to minimize the difference between the polyimide base film and the conductor layer. With respect to the enhance adhesion surface treatments, Hara et al do not specifically teach applying a Si, Ti or Al compound in order to introduce the desired functional groups, however, as discussed previously, organic silane coupling agents, titanate coupling agents and aluminum coupling agents are all obvious surface treatment agents for improving adhesion between a polyimide resin and metal and would have been obvious to one

having ordinary skill in the art at the time of the invention given the predictable results and reasonable expectation of success.

7. Claims 1-3, 5-9 and 11-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Katsuki et al for the reasons of record and restated below.

8. Katsuki et al teach a method of making a polyimide laminate having a thin metal layer, preferably copper, formed on one or both surfaces of a polyimide film comprising a two- or three-layer film having a thermoplastic polyimide layer on one or both surfaces of a highly heat resistant polyimide base layer; wherein the thermoplastic layer has a Tg of 200° to 300°C, and the highly heat resistant polyimide base layer has a linear expansion coefficient of $5x10^{-6}$ to $25x10^{-6}$/°C (*reads upon claimed difference in expansion coefficients*; Col. 3-Col. 4; Col. 5, lines 20-65.) Katsuki et al teach that the polyimide laminate is subjected to a surface treating method and that the treated polyimide film has improved adhesion to metal formed by vapor deposition or a combination of vapor deposition and electroless plating and/or electroplating, wherein the metal layer comprises a first metal layer formed by vapor deposition such as sputtering, a second metal layer formed by vapor deposition and/or plating, and an outer metal layer formed by plating, wherein the first metal layer such as titanium can provide good adhesion between the polyimide film and the second metal layer (Col. 6-7.) Katsuki et al teach that the polyimide laminate is subjected to a heating treatment at a temperature above the Tg of the thermoplastic polyimide and below a temperature causing deterioration of the thermoplastic polyimide, and that prior to depositing the metal layers, the polyimide laminate is preheated to a temperature of 30° to 280°C (Col. 5, lines 37-48; Col. 7, lines 34-42.) Katsuki et al also teach that the thin

metal layer can be subjected to an etching step and may be utilized as a substrate in making FPCs, TAB tape carriers, multilayer FPCs, and rigid-flex circuit boards (Col. 7-8.)

9. Though Katsuki et al teach that the polyimide surface can be subjected to various surface treatments to improve adhesion to the metal layer, Katsuki et al do not specifically teach applying an organic coupling agent as instantly claimed, however, as discussed previously, organic silane, titanate and aluminum coupling agents are well known and obvious adhesion promoting agents in the art and would have been obvious to one having ordinary skill in the art at the time of the invention given the predictable results and reasonable expectation of success. With respect to Claim 6, though Katsuki et al do not specifically teach the claimed modulus, one having ordinary skill in the art at the time of the invention would have been motivated to utilize routine experimentation to determine the optimum polyimide and layer thickness to provide the desired elastic modulus for a particular end use wherein the claimed range is typical in the art. Lastly, though Katsuki et al teach that the laminate can be utilized to produce printed circuit boards and that the metal can be etched, Katsuki et al do not specifically teach utilizing a resist film however the use of a resist film to provide the desired circuit pattern would have been obvious to one having ordinary skill in the art at the time of the invention.

10. Claims 1-3, 5-9 and 11-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al for the reasons of record and restated below.

11. Tanaka et al teach a laminate comprising a two-layer or three-layer structure including a non-thermoplastic polyimide base film and a thermoplastic polyimide layer provided on one or both surfaces thereof, wherein the surface of the thermoplastic polyimide layer(s) is surface-

treated to improve adhesion to subsequently applied metal layer(s) (Abstract.) Tanaka et al teach that the laminate can provide a printed circuit board with excellent adhesiveness, on which a micro-wiring circuit can be formed (Abstract.) Tanaka et al teach that the thermoplastic resin of the thermoplastic layer has a Tg of preferably 350°C or less, most preferably 280°C, and preferably more than 150°C (Paragraph 0110) Tanaka et al teach that the polymer base film has a coefficient of linear expansion of 2.0 $x10^{-5}$/°C or less, more preferably $1.5x10^{-5}$/°C or less, and most preferably 1x10-5/°C or less; and a tensile modulus of 5 GPa or more (which would be meet the limitation of being less than $15x10^{-6}$ different than the metal or copper; Paragraph 0119-0122.) Tanaka et al teach that a metal layer serving as a conductor layer can be formed by a wet plating method such as electroless plating or a dry plating method such as sputtering or vapor deposition (Paragraph 0156.) Tanaka et al teach that a circuit can be provided utilizing a resist layer or partially etching the metal layer as instantly claimed (Paragraph 0158, 0162-0163.)

12. Though Tanaka et al teach that the polyimide surface can be subjected to various surface treatments to improve adhesion to the metal layer, Tanaka et al do not specifically teach applying an organic coupling agent as instantly claimed, however, as discussed previously, organic silane, titanate and aluminum coupling agents are well known and obvious adhesion promoting agents in the art and would have been obvious to one having ordinary skill in the art at the time of the invention given the predictable results and reasonable expectation of success.

Response to Arguments

13. Applicant's arguments filed 2/23/10 have been fully considered but they are not persuasive. The applicant argues that the applied references fail to teach, suggest, or establish any reason or rationale to provide an organic substance having at least one or more kind of

element selected from Si, Ti, and Al at the joining interface toward the metal layer or on the thermoplastic film before forming the metal layer by vapor deposition. The Examiner notes that in general, the Applicants recite the teachings of each reference but fail to rebut the Examiner's position that incorporation of the claimed coupling agents, which are known, conventional coupling agents utilized in the art to provide improved adhesion between layers including at a polymer/metal interface, would have been obvious to one having ordinary skill in the art at the time of the invention. As discussed previously, the Examiner notes that all of the references, teach forming a metal layer by vapor deposition on a thermoplastic film layer after surface treating the thermoplastic film layer to improve adhesion of the metal to the thermoplastic. With regards to Summers et al, the Applicant argues that Summers et al teach the use of silane coupling agent as an alternative to the use of an adhesive or vapor deposition and hence one having ordinary skill in the art at the time of the invention would not have been motivated to combine these individual, alternative teachings to arrive at the instant invention or to treat the thermoplastic adhesive layer with the silane coupling agents. However, the Examiner respectfully disagrees and maintains her position that given the teachings of Summers et al with respect to improving adhesion between a polyimide and metal, in general, one having ordinary skill in the art at the time of the invention would have been motivated to combine all three of these known methods of improving adhesion between the polyimide and the metal to yield predictable results, namely improved adhesion. With regards to Hara, the Applicant argues that Hara recites that the laminate has excellent adhesion strength between the conductor layer and the polyimide film without performing any surface roughening treatment or using any adhesive metal layer and hence one having ordinary skill in the art would not have been motivated to

utilize the claimed coupling agents because they are surface treatment agents. However, as clearly articulated in the rejection, Hara actually recites in Paragraph 0044 of the body of the specification that "[t]he effects of the invention are not worsened by physically roughening the polyimide surface before the formation of the conductor layer, roughening the polyimide surface by a plasma treatment in an inert gas and/or introducing a functional group, or using an adhesive metal layer to thereby **further enhance** the adhesion strength" (emphasis added) and hence Hara do provide a suggestion of further enhancing the adhesion strength by these methods. With regards to Applicant's arguments that the Examiner is taking "Official Notice" that all coupling agents will behave identically, the Examiner respectfully disagrees and notes that in the rejection with respect to Hara as well as Katsuki and Tanaka, the Examiner has clearly articulated that surface treatment with an organic silane coupling agents is a known method or technique to yield predictable results, namely a known method of improving adhesion between a polyimide film and a metal coating or layer, as clearly evidenced by the other references already made of record such as Summers et al as well as Watanabe et al, and hence, the Examiner maintains her position that the instantly claimed invention would have been obvious over the teachings of Hara, Katsuki and Tanaka given the predictable results, namely improved adhesion, and reasonable expectation of success. As for Applicant's arguments of unexpected results, the Examiner notes that improved adhesion is not an unexpected results when utilizing the claimed coupling agents at a bonding interface between two layers and hence Applicant's arguments are not persuasive and the Examiner maintains her position that the claimed invention would have been obvious over the prior art.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Monique R. Jackson whose telephone number is 571-272-1508. The examiner can normally be reached on Mondays-Thursdays, 10:00AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Callie Shosho can be reached on 571-272-1123. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/Monique R Jackson/
Primary Examiner, Art Unit 1794
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